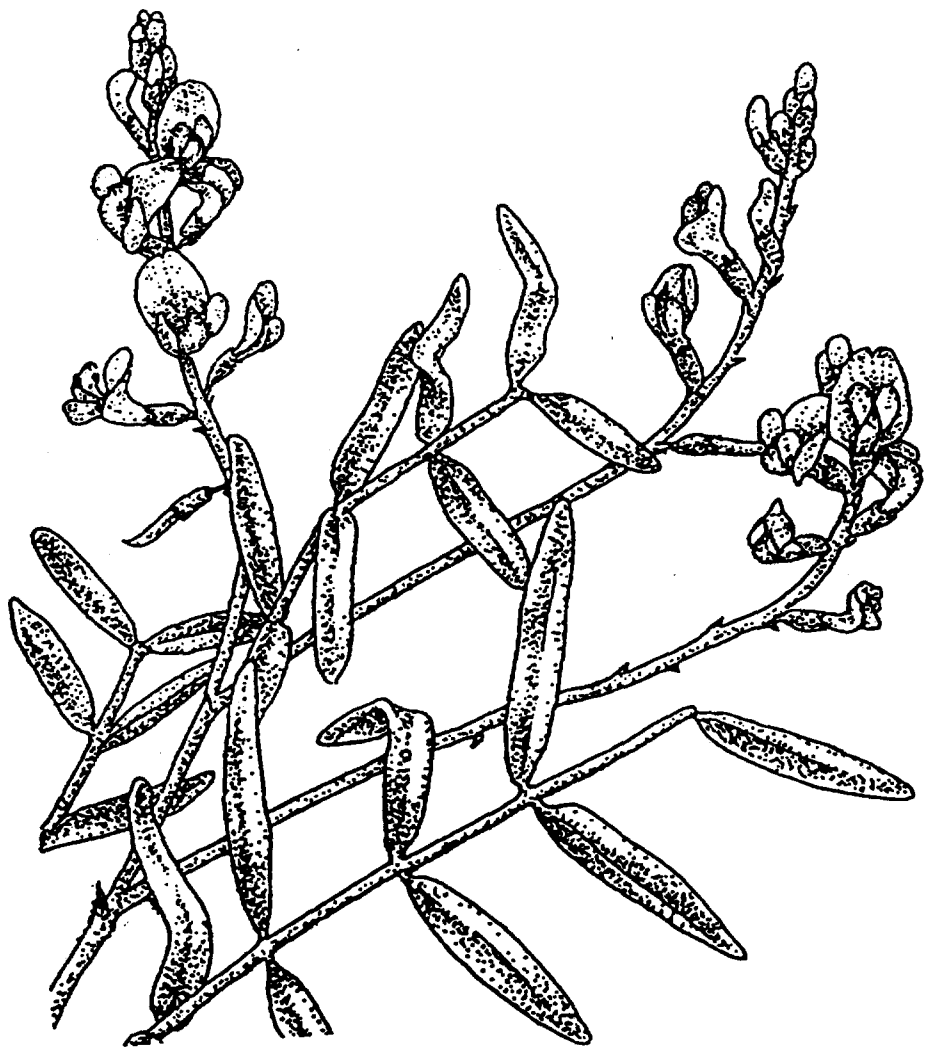
U.S. Fish and Wildlife Service

Recovery Plan

For the Applegate's Milk-vetch (Astragalus applegate)



Applegate's milk-vetch
(*Astragalus applegatei*)

RECOVERY PLAN

Prepared by

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Plant Conservation Biology Program

for

Region 1
U.S. Fish and Wildlife Service

Approved: _____
Regional Director, U.S. Fish and Wildlife Service

Date: 4/10/98

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Literature citation should read as follows:

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EXECUTIVE SUMMARY

Current Status: Applegate's milk-vetch (*Astragalus applegatei* Peck) is a perennial plant species in the legume family (Fabaceae) listed as endangered by the U.S. Fish and Wildlife Service. Believed extinct until its rediscovery in 1983, Applegate's milk-vetch is currently known from only three sites, collectively supporting an estimated 12,000 individuals. The species is a narrow endemic, known only from the Lower Klamath Basin (i.e., the plain containing Lower Klamath Lake) near the city of Klamath Falls, Klamath County, in southern Oregon.

Habitat Requirements and Limiting Factors: Applegate's milk-vetch is restricted to flat-lying, seasonally moist, strongly alkaline soils. Although currently replete with introduced grasses and other weeds, the species' habitat was historically characterized by sparse, native bunch grasses, and patches of bare soil. Intensive agricultural and urban development of the Klamath River floodplain has resulted in severe depletion and fragmentation of the species' habitat. The plant is known to be extant at only three sites. The largest continues to face imminent attrition through industrial development on private lands. Virtually all remaining potential (undeveloped) habitat for the species has been seriously modified by the proliferation of weeds, suppression of floods and fires, and land reclamation projects involving extensive construction of drainage ditches and water retention dikes.

Because of habitat modification, Applegate's milk-vetch may be limited by competition from exotic weeds. Threats to this plant are intensified by the small number and limited distribution of remaining populations, which increases the milk-vetch's vulnerability to extirpation due to random mortality events. Furthermore, two of the three extant populations support fewer than 500 individuals, possibly not enough to maintain the genetic variability necessary for long-term population viability. Expansion of populations of Applegate's milk-vetch appears to be limited by caterpillars feeding on the plants, low seed production, and seed loss to pre-dispersal predation by adult and larval beetles.

Recovery Objective: Downlisting to threatened status.

Recovery Criteria: Applegate's milk-vetch may be considered for downlisting to threatened status when at least six natural and/or introduced self-sustaining populations are preserved in habitat permanently secured and managed for the benefit of the species. Until demographic monitoring shows otherwise, self-sustaining populations will be defined as containing a minimum of 1,500 reproductive plants, including sufficient individuals in younger age classes to suggest population stability or growth. A detailed discussion of these criteria is provided in Part II of this recovery plan.

Actions Needed:

1. Conserve natural and introduced Applegate's milk-vetch populations.
2. Long-term, off-site seed storage.
3. Conduct research on population sustainability, population establishment and augmentation techniques, efficacy of habitat management strategies, and the plant's edaphic and hydrologic requirements.

Total Cost of Downlisting ($1,000):

Year	Need 1	Need 2	Need 3	Total
1998	48.0	2.5	48.0	98.5
1999	66.0	2.5	48.0	116.5
2000	44.0	2.5	48.0	94.5
2001	44.0	2.5	28.0	74.5
2002	44.0	2.5	28.0	74.5
2003	45.5	4.0	8.0	57.5
2004	46.0	4.0	8.0	58.0
2005	133.5	4.0	8.0	145.5
2006	126.0	4.0	8.0	138.0
2007	126.0	4.0	8.0	138.0
2008	117.0	7.0	8.0	132.0
2009	99.0	7.0	12.0	118.0
2010	99.0	7.0	8.0	114.0
Total	**1038.0**	**53.5**	**268.0**	**1359.5**

Date of Downlisting: 2010

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PART I

INTRODUCTION

Applegate's milk-vetch (*Astragalus applegatei* Peck) is listed as an endangered species under the authority of the Endangered Species Act (Act) of 1973, as amended (58 FR 40551, 1993). The U.S. Fish and Wildlife Service is responsible for preparing a recovery plan for the species that guides its conservation so it can be downlisted from endangered to threatened status and eventually be delisted.

A. Description of Species

Astragalus is an enormous genus in the legume family (Fabaceae), with 74 taxa (species and varieties) in Oregon alone (Liston 1997), primarily from east of the Cascades. Applegate's milk-vetch (see cover illustration) is a taprooted, herbaceous, perennial plant. The numerous tufted or trailing stems are 2.5-8 decimeters (10-33 inches) long, simple or branching, and may be smooth or have sparse stiff, short hairs. Leaves are 3.5-12 centimeters (1.5-5 inches) long, are on petioles, and have 7-11 linear to linear-elliptic flat leaflets, the terminal one usually the longest. Racemes typically bear 5-20 pea-like flowers with lavender-tipped white petals. The 8-13 millimeters (0.4-0.6 inches) long, stalked fruit pods are oblong, compressed, have short hairs and frequently have green or purple speckled valves. Pods split apart from the top (dehisce apically) then downward through the ventral suture, and contain up to 10 (but usually fewer than 3) dark brown minutely dotted seeds with depressions (Peck 1936, Barneby 1964, S. Gisler, personal observation).

Three other related species of *Astragalus* occur within the geographic range of Applegate's milk-vetch: *A. filipes*, differentiated by its erect growth and banners lacking purple pigmentation, *A. purshii*, which is sub-prostrate to erect, has long soft wavy hairs, and produces densely wooly pods, and *A. lemmonii*, distinguished by its sessile, fully bilocular pods, and compact racemes on stalks paired in the leaf axils (Barneby 1964).

B. Distribution

Applegate's milk-vetch is restricted to (endemic to) the Lower Klamath Basin, in Klamath County, Oregon, about fifteen miles north of the Oregon-California border. The

species is historically known from only four sites. Today, it is known to exist at only three sites (Figure 1), all situated approximately 4,100 feet above sea level. The largest population (Ewauna Flat) contains an estimated 11,500 individuals and is located near Ewauna Lake at the southern edge of the city of Klamath Falls. This population currently consists of three distinct, locally aggregated patches of plants[1]. A significant portion (nearly seven acres) of this population, where the greatest density of plants occurs, is owned and managed by The Nature Conservancy (TNC), while the remainder of the population is scattered on other private lands.

The second extant population (Miller Island) occurs at the Klamath Wildlife Area, located about six miles southwest of Klamath Falls, near the town of Midland. This population includes four small patches of plants[2], cumulatively containing fewer than 500 individuals. This site is owned and managed by the Oregon Department of Fish and Wildlife.

The third extant population (Wordon) occurs within the vicinity of Wordon, Oregon, approximately three miles north of the California border. Three plants were discovered in May 1997 by Nick Testa, botanist for the Oregon Department of Transportation (N. Testa, pers. comm. 1997).

Herbarium records indicate that Applegate's milk-vetch was once more widespread, occurring in a fourth area two miles east of the town of Keno, Oregon, located about ten miles southwest of Klamath Falls. This was the area of Peck's type[3] collection of the species (Peck 1936, Barneby 1964). Efforts to relocate Applegate's milk-vetch in the Keno area have proven unsuccessful; widespread habitat conversion to fields and pastures has likely displaced the species in this portion of its historic range.

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1 Includes Oregon Natural Heritage Program occurrences: PDFAB0F0P*003,004,005

2 Includes Oregon Natural Heritage Program occurrences: PDFAB0F0P0*002,006,007

3 The scientific names of plants are based on herbarium specimens designated by the describer of the species or by namer or later taxonomic revisers as "types". This specimen was designated as the type by Peck and holotype by Barneby.

Given the species' affinity for alkaline, floodplain habitat, and its current and documented historic distribution, it is probable that Applegate's milk-vetch once occurred along the fringes of the marshes and floodplain of Upper Klamath Lake and Ewauna Lake, and very likely other areas throughout the pre-settlement Lower Klamath Basin.

C. Life History/Demography

Flowering in Applegate's milk-vetch typically commences in early June and continues to August. Fruits shed their seed shortly after flowering and exhibit no specialized mechanisms for long-distance seed dispersal. Although the species' historical occurrence on patches of bare soil (Yamamoto 1985, TNC 1996) may have allowed for some wind movement of seeds along the soil surface, today's dense coverage of the habitat by introduced grasses and weeds likely eliminates any significant post-dispersal eolian seed movement. Some seed dispersal may take place through ingestion by rodents or jackrabbits, although this has not been documented. Localized seed dispersal is supported by field observations, which document that the majority of seedling establishment is immediately adjacent to mature plants (Yamamoto 1985, Oregon Department of Agriculture [ODA] unpublished). Following completion of flowering, above-ground portions of plants die back completely, succeeded in late fall by resprouting of short, 1-5 centimeters (0.5-2 inch) stems bearing immature leaves, formed directly above the root crown (ODA unpublished).

Reproduction in Applegate's milk-vetch takes place exclusively by seeds. There is no evidence that the species is capable of asexual, vegetative reproduction. Pollination is probably mediated by the butterflies and polylectic bees observed visiting the species (see Section D—associated fauna), although this milk-vetch is also capable of significant seed production through self fertilization (autogamy) (ODA, unpublished). Self-fertilization is common in the genus *Astragalus*, facilitated by simultaneous ripening of anthers and stigmas (Barneby 1964). Self-compatibility is a typical reproductive strategy for rare, locally endemic species, as enough plants may not be flowering at any one time, or not in adequate concentration to reliably attract foraging pollinators (Karron 1987, Geer *et al.* 1995).

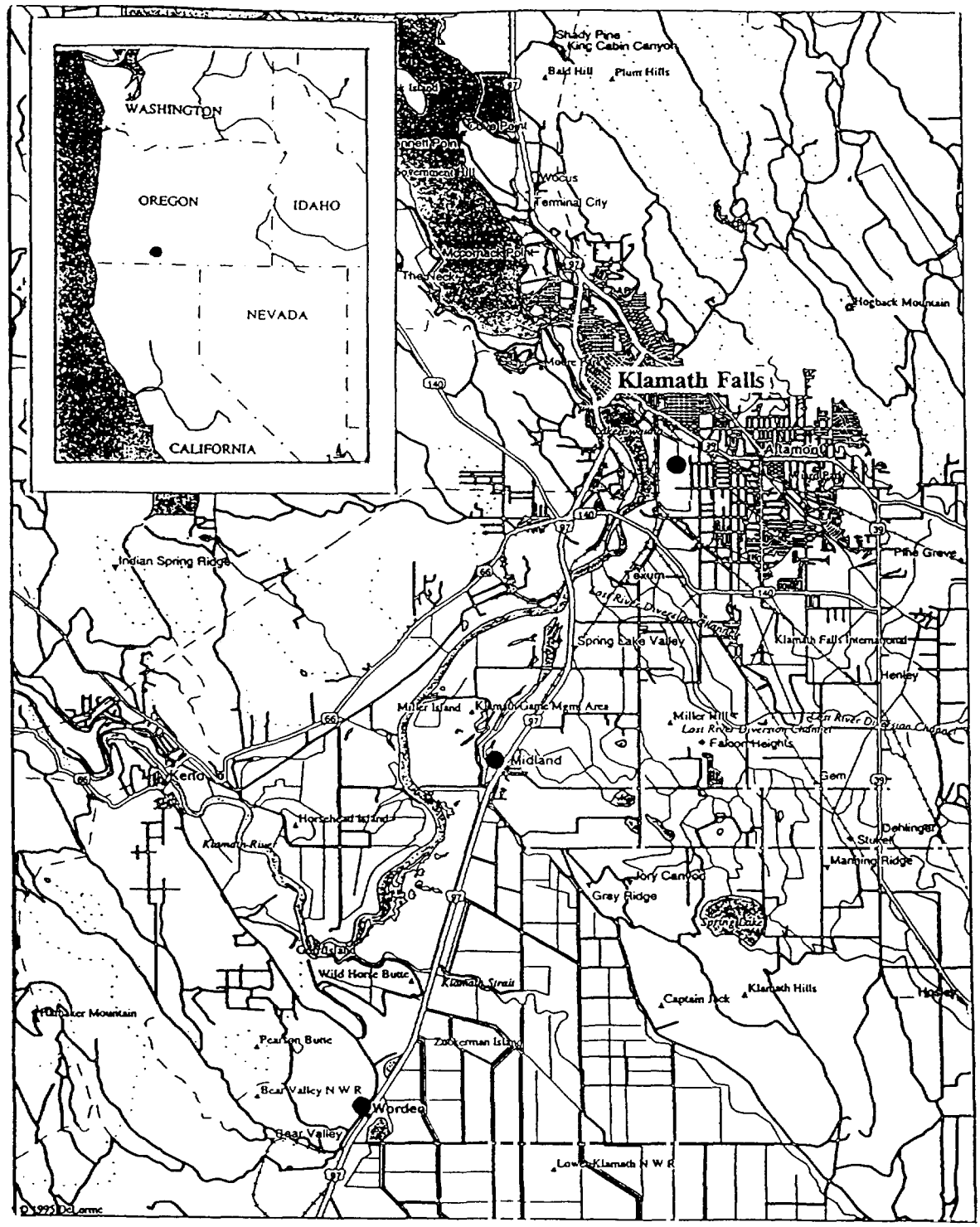

Figure 1. Distribution of the three known extant Applegate's milk-vetch populations, represented by black dots. The species is endemic to Klamath County, Oregon.

Although Applegate's milk-vetch fruits typically contain 8-10 ovules, production of greater than 3 (if any) seeds per pod is rare, based upon the last four years of observation by the authors. It is unknown to what degree seed production may be limited by environmental, pollinator, and inherent genetic constraints. Reproductive output is further limited by pre-dispersal seed predation and inflorescence herbivory by butterfly larvae (ODA, unpublished).

The seeds germinate readily in the greenhouse after scarification of the seed coat, usually within three to five days of imbibing water. Greenhouse seedlings develop rapidly, and can reach reproductive size within six months of seed germination (ODA, unpublished). Timing and levels of seed germination in nature are unknown, as is seed longevity, extent of soil seed bank formation, and levels of post-dispersal seed mortality. Questions remain about other aspects of Applegate's milk-vetch's life history, including levels of seedling recruitment, natural rates of plant development, plant longevity, frequency and duration of plant dormancy, outcrossing rates, and to what degree parent and progeny fitness is related to self- versus cross-pollination.

D. Habitat/Ecology

It is difficult to confidently predict the milk-vetch's specific habitat requirements based upon the modified and degraded ecosystem the species currently occupies. Nevertheless, historical observations, ongoing field work, and what remains of its habitat, have all yielded some insight into the species' probable ecological requirements.

Soils

Perhaps the most striking feature of the milk-vetch's habitat is the soil, which, as evidenced by a white crust on the surface, is strongly alkaline, with a pH 7.9-9.6 (Soil Conservation Service [SCS] 1985). Little is known about alkalinity tolerance in the species, or to what degree edaphic specialization may have historically maintained the species against competitive exclusion by other less alkaline-tolerant native taxa. Recent invasion of the habitat by exotic plant species with broad environmental tolerances has resulted in formation of the dense vegetative cover now present at extant Applegate's milk-vetch populations. In addition to their alkalinity, soils

harboring the species are sparsely vegetated (at least prior to colonization by weeds), seasonally moist, lack a litter layer, and have an underlying clay hardpan (SCS 1985; S. Gisler, personal observation). There is also emerging evidence from Applegate's milk-vetch propagation studies that site soils may harbor mycorrhizal fungi and *Rhizobium* bacteria beneficial to the survival and growth of the milk-vetch (ODA, unpublished). These studies also suggest that strong alkalinity is not a requirement for growth and reproduction in the species. As with other plants growing under extreme conditions of alkalinity, heavy metals, salinity, etc., Applegate's milk-vetch may benefit from alkaline soils to help reduce competition from other species.

The Ewauna Flat population occurs on Henley-Laki loams, with a few scattered plants on Hosley loam. The Miller Island population primarily occurs on Henley loamy fine sand, with scattered plants on Henley loam and Henley-Laki loams. The Wordon population occurs on Calimus fine sandy loam.

Hydrology

Prior to extensive ditch and dike construction, the floodplains occupied by Applegate's milk-vetch likely experienced periodic, seasonal flooding, and may have exhibited other hydrologic attributes not present today. Despite the alterations, the floodplains are still markedly moist in the winter and spring, which may be due, in part, to the clay hardpans underlying the known sites for Applegate's milk-vetch. Hardpans impede water percolation, providing seasonal soil moisture saturation and retention. Applegate's milk-vetch presumably is adapted to, and may require, this hydrologic regime. Soil moisture may exclude plants that require dry conditions, creating a niche for Applegate's milk-vetch. It appears that habitat modifications have affected plant succession and vegetative cover leading to increases in quackgrass *(Elytrigia repens)* and annual brome grasses (*Bromus* spp.).

Associated vegetation

Photos taken as recently as 1983 show Applegate's milk-vetch growing on bare ground among native bunchgrasses and occasional shrubs (TNC 1996). A U.S. Fish and Wildlife Service (USFWS) status report written in 1985 characterizes the species' habitat as a grassland community/bunchgrass flat with 10-20 percent bare ground

(Yamamoto 1985). Today, although Applegate's milk-vetch sites still support an interesting variety of native taxa, the species is primarily found in the company of non-native grasses and herbs. Patches of bare soil have become relatively rare, except in areas too compacted, moist, or alkaline to support any vegetation at all. Some of the more prominent plants currently associated with Applegate's milk-vetch include big sagebrush (*Artemisia tridentata*), brome grass (*Bromus* spp.), Indian paintbrush (*Castilleja pilosa*), rabbitbrush (*Chrysothamnus* spp.), tansy mustard *(Descurainia californica)*, saltgrass (*Distichlis stricta*), Great Basin wildrye (*Leymus cinereus* [= *Elymus cinereus*]), quackgrass (*Elytrigia repens* [= *Agropyron repens*]), foxtail barley (*Hordeum jubatum*), peppergrass (*Lepidium perfoliatum*), sweetclover (*Melilotus* spp.), bluegrasses (*Poa juncifolia, P. nevadensis*), Lemmon's alkali grass (*Puccinellia lemmonii*), greasewood (*Sarcobatus vermiculatus*), squirreltail (*Sitanion hystrix*), salsify (*Tragopogon dubius*), and alfalfa (*Medicago sativa*) (ODA, unpublished).

Associated fauna

Numerous animals have been observed in association with Applegate's milk-vetch. Vertebrates, and potential herbivores, include jackrabbits, Canada geese, and voles. Meadowlarks are also common (and pleasantly heard) occupants of Applegate's milk-vetch habitat. Applegate's milk-vetch is visited by numerous insects, with prominent visitors including bumble bees (Apidae: *Bombus* spp.), other polylectic bees (Megachilidae: *Osmia* spp.; Andrenidae: *Andrena* spp.), bee-flies (Bombylidae), and the butterflies *Lycaedes argyrognomon* (Yamamoto 1985) and *Plebejus melissa* (ODA, unpublished). The larvae of the latter also utilize Applegate's milk-vetch as a host plant, causing severe plant damage through herbivory. These caterpillars are often tended and fiercely defended by ants which patrol plant stems and leaves. Other associated insects include root weevils (Curculionidae: *Sitona californicus, S. hipidulus*), click beetles (Elateridae), and long-horned beetles (Cerambycidae) (ODA, unpublished).

E. Reasons for Listing and Current Threats

Habitat loss and modification

As previously discussed in Part IB, Applegate's milk-vetch was likely more abundant and widespread before intensive agricultural and urban development of the Klamath River floodplain, accompanied by extensive water control/land reclamation projects. Changes in land use have resulted in widespread depletion, fragmentation, and modification of Applegate's milk-vetch habitat, to the extent that even small (an acre or less) parcels of truly undisturbed habitat are virtually non-existent. Repeated efforts to relocate the species in its type locality near the town of Keno, Oregon, have proven unsuccessful, revealing only degraded remnants of potential habitat along fence rows and roadsides.

Not exclusively an historical problem, habitat loss to development continues to threaten Applegate's milk-vetch. The site of one large patch of plants (part of the Ewauna Flat population) was destroyed during the last decade. The area now supports an auto dealership and grocery store. A similar fate awaits additional portions of this population occurring on private lands currently posted for sale as industrial lots.

Loss of potentially suitable, but currently unoccupied, habitat indirectly threatens the milk-vetch by reducing the reservoir of possible localities for future population colonization and expansion, as well as artificial population establishment (a recovery strategy discussed in Part II). No other indirect threats been documented, but possible threats could include the impacts of agricultural and urban development on local populations of native ground-nesting bees, which are important milk-vetch pollinators.

Beyond outright habitat loss, modification of remaining habitat also poses serious obstacles to the survival and recovery of the species. In addition to the ubiquitous proliferation of introduced weeds (discussed below), extensive construction of drainage ditches and dikes throughout the Lower Klamath Basin has altered the hydrologic character of Applegate's milk-vetch habitat. Drainage ditches carry away rainwater that may otherwise be retained in soils, and, in conjunction with dikes, reduce (if not eliminate entirely) the frequency and severity of flooding. These changes could result in lethally dry conditions for Applegate's

milk-vetch, or may indirectly impact the species by allowing immigration of more drought-tolerant plants, including many exotic grasses.

Although there is no information on the frequency or intensity of natural fires pre-dating European settlement of the Klamath River floodplain, natural fires may have played an important role in maintaining open habitat for Applegate's milk-vetch, clearing plant litter and encroaching woody shrubs. Fires may also have promoted seed germination and controlled seed predator populations. Research is needed to determine the potential negative impacts of modern fire suppression (or the potential positive effects of fire re-introduction) on Applegate's milk-vetch. Anecdotal information suggests that recent fires at the Miller Island population may have promoted reproduction and recruitment in the species.

Competition with exotic weeds

Applegate's milk-vetch once occupied patches of bare soil between sparse bunchgrasses and occasional shrubs (see Part IC, above). Today the species' habitat is replete with aggressive, introduced weeds, an invasion that could severely affect Applegate's milk-vetch. Foremost among these may be displacement of Applegate's milk-vetch through competitive exclusion. The competitive ability of the milk-vetch against exotic weeds is unknown. Although established individuals may be large enough to persist under weedy conditions, competition may inhibit seedling establishment, which lack the stout taproots, microbial affiliations, and energy reserves of mature plants. Given the potentially dire consequences of inhibited population regeneration, further research on the impacts of competition on Applegate's milk-vetch is urgently needed.

Habitat colonization by exotics could indirectly limit Applegate's milk-vetch by creating, through increased input of plant litter and nitrogen fixation by introduced legumes, conditions favorable to secondary succession by shrubs and other herbaceous species historically held at bay by the once harsh, bare soils. Likewise, habitat colonization by weeds, especially thatch-forming grasses, could promote greater densities of voles and other potential plant herbivores and granivores, through provision of increased cover and protection from predators.

Immigration of exotic species could also indirectly affect Applegate's milk-vetch through alterations to the foraging behavior of its pollinators. Although some studies suggest that pollination in rare species may be facilitated by other more abundant plant species in the same habitat (Rathcke 1983, Geer *et al.* 1995), the contrary is equally plausible—the presence of other plants may actually result in competition for the services of pollinators. Tall exotics with numerous showy flowers, and showy inflorescences, such as *Melilotus*, may be particularly adept at outcompeting the comparatively low-growing and inconspicuous Applegate's milk-vetch for pollinators. In addition to pollinator competition, pollinator sharing between taxa could limit reproduction in Applegate's milk-vetch due to stigmatic clogging by pollen from other species. Polylectic bees such as those observed on Applegate's milk-vetch are considered generalist pollinators, commonly utilizing numerous (multi-taxa) floral resources (Heinrich 1975, Motten *et al.* 1981; Karron 1987). Although seed set through autogamy could help offset the immediacy of pollinator-related threats, further research is needed to investigate the impacts of self-fertilization on plant/progeny fitness.

The Nature Conservancy is conducting mowing and burning experiments to help understand how much the exotic plants influence the population dynamics of Applegate's milk-vetch. Recovering Applegate's milk vetch depends on understanding the potentially diverse consequences of habitat colonization by exotic plants.

Herbivory and seed predation

Oregon Department of Agriculture personnel have observed severe damage to Applegate's milk-vetch plants due to herbivory by caterpillars, identified as the larval stage of *Plebejus melissa*, which is also a potential pollinator of the milk-vetch (although probably a minor one). As many as seven caterpillars have been collected from a single Applegate's milk-vetch individual, with plants commonly suffering complete defoliation. Similar damage, although generally less severe, has been observed on nearby sweetclover and alfalfa plants (also legumes). Both Applegate's milk-vetch populations suffer from herbivory, which may threaten the plants at the smaller population at Miller Island (ODA, unpublished). Whereas occasional herbivory may result in only short-term setbacks to individuals, herbivory over consecutive years may weaken or kill plants, contribute to depletion of soil seed banks (if such exist), and impact population recruitment.

Applegate's milk-vetch also suffers seed loss due to pre-dispersal seed predation. Seed predation studies indicate per-plant seed losses of nearly 30 percent. The significance of even low levels of seed predation is enhanced by the already limited number of seeds produced by the species. Insect larvae responsible for seed loss in the species have not been identified, but are almost certainly a beetle or weevil. Further research is needed to understand the extent, impacts, and possible control of herbivory and predation.

Limited seed production

Although flowers of Applegate's milk-vetch have 8-10 ovules that can mature into seeds, only rarely do more than three do so (based upon four years of observation by the authors). Low seed sets among irrigated, fertilized, greenhouse-grown, and hand-pollinated plants (ODA, unpublished) suggest that seed set is not a result of water or macronutrient deficiency, but may be limited by intrinsic genetic factors (possibly inbreeding depression) or other resource constraints. As with seed predation and inflorescence herbivory, low seed production may adversely affect population dynamics and generation of soil seed banks. The latter are extremely important, as they represent genetic reserves that may enable populations to rebound from disturbances affecting established plants.

Population viability

Although the largest of the three extant Applegate's milk-vetch populations supports an estimated 11,500 individuals, the other known populations contain fewer than 500 plants, which may be insufficient for the population to be present 100 years from now. Demographic monitoring may be necessary to determine the minimum population sizes needed for long-term viability. Likewise, because little as is currently known about the age structure and levels of recruitment in Applegate's milk-vetch populations, studies of population characteristics are needed to assess the long-term viability of populations in terms of age (or, more accurately, growth stage) structure. If seedlings and young (non-reproductive) plants are present in only small numbers, this could indicate limitations to reproduction and recruitment, and the eventual decline of populations as mature plants fall victim to habitat degradation and predation.

F. Current Conservation Measures

Many conservation measures have already been undertaken for Applegate's milk-vetch, including legislation, inventories for the species, research, habitat acquisition, and habitat management.

Legal protection. Applegate's milk-vetch was listed as an endangered species by the U.S. Fish and Wildlife Service on June 28, 1993, under the authority of the Endangered Species Act of 1973, as amended (58 FR 40551, 1993). This designation requires all federal agencies to ensure that activities they authorize, fund, or carry out are not likely to jeopardize the continued existence of the species. The Endangered Species Act also regulates interstate and foreign trade in Applegate's milk-vetch.

Applegate's milk-vetch is also regulated under Oregon's State Endangered Species Act, where it is listed as an endangered species (OAR 603-73-070, 1995). Regulations under state law are similar to those under the federal Endangered Species Act, requiring all state agencies (including county, city, and municipal subdivisions of the state) to ensure that activities they authorize, fund, or carry out on state-owned lands are not likely to adversely affect listed species. State laws also regulate commercial trade in Applegate's milk-vetch within Oregon.

Inventory. Extensive, but not exhaustive inventories have been conducted for Applegate's milk-vetch throughout most portions of its presumed historic range. This work resulted in the discovery of the three known populations. The species had previously been believed to be extinct. Surveys have been conducted by the Oregon Natural Heritage Program and Oregon Department of Agriculture personnel. Biological inventories have also been conducted by the Oregon Department of Transportation on state highway right-of-ways before initiating potentially destructive land actions. Inventories, in addition to discovering populations, have confirmed the extreme rarity of Applegate's milk-vetch and improved our understanding of remaining habitat availability in the Lower Klamath Basin.

Research. Various research projects have been, and are currently being conducted to increase our knowledge about Applegate's milk-vetch. Areas of research include: habitat analysis (TNC and ODA), population monitoring (TNC), reproductive and pollination biology (ODA and TNC), propagation (TNC and ODA) and transplantation (ODA), seed predation (ODA), mycorrhizal and other microbial studies (ODA), and experimental habitat management treatments (TNC).

Habitat acquisition. A significant portion (nearly seven acres) of the largest extant Applegate's milk-vetch population (Ewauna Flat) near Ewauna Lake in Klamath Falls was recently purchased by TNC, providing urgently needed security against habitat loss to development. However, less than half of the nearly seven-acre tract appears to support or to have supported the population.

Management. The Applegate's milk-vetch population at Miller Island is managed by the Oregon Department of Fish and Wildlife, and is afforded protection from grazing, vehicular traffic, development, and other potentially destructive activities. The Nature Conservancy has fenced its portion of the Ewauna Flat population, and is experimenting with prescribed burning, herbicide application, and mowing in management of Applegate's milk-vetch habitat.

PART II. RECOVERY

A. Objective

The ultimate objective of the following recovery actions is to increase the stability of Applegate's milk-vetch to the point where it is no longer in danger of extinction, thereby meriting consideration for downlisting from endangered to threatened status on the Federal list of endangered and threatened plants.

Criteria for downlisting to threatened: Applegate's milk-vetch will be considered for downlisting to threatened status when at least two natural and/or introduced self-sustaining populations are preserved in each of the three recovery areas, for a total of six or more populations in habitat permanently secured and managed for the benefit of the species. The minimum of two populations per recovery area is needed to reduce the chance that a single catastrophic event could destroy that recovery area's entire genetic pool. A minimum of 4,500 reproductive plants is needed for a recovery area to meet the downlisting threshold. The three recovery areas are Ewauna Flat, Miller Island, and Wordon. If an extant population is found in the Keno area, this population should be preserved as a fourth recovery area and the recovery plan revised accordingly.

Although stochastic events, such as floods, droughts, and fires may have the most significant short term effects on small plant populations, it is believed that genetic variability may be crucial for adaption to longer-term changes such as climate, not to mention. Therefore until demographic studies show otherwise, self-sustaining populations will be defined as containing a minimum of 1,500 reproductive plants, plus sufficient individuals in younger age classes to suggest population stability or growth.

B. Stepdown Outline of Recovery Actions and Tasks

1. Conserve natural and introduced populations
   - 1.1 Survey for undiscovered populations
     - 1.11 Review aerial photos
     - 1.12 Prioritize search areas
     - 1.13 Acquire landowner permission
     - 1.14 Conduct inventories
   - 1.2 Survey for sites to establish populations
   - 1.3 Select population preservation and establishment sites
   - 1.4 Secure extant populations and establishment sites
     - 1.41 Acquire habitat
     - 1.42 Delineate boundaries
   - 1.5 Establish introduced populations
     - 1.51 Collect seeds
     - 1.52 Propagation
     - 1.53 Prepare Sites
     - 1.54 Population establishment (outplanting)
   - 1.6 Habitat management
     - 1.61 Determine management needs
     - 1.62 Develop written management plans
     - 1.63 Implement management actions
   - 1.7 Evaluate population status
     - 1.71 Population census
     - 1.72 Demographic monitoring
     - 1.73 Assess population augmentation needs
   - 1.8 Augment populations (if necessary)

2. Long-term, off-site seed storage
   - 2.1 Collect seeds
   - 2.2 Store and test seeds for viability

3. Conduct further research
   - 3.1 Define population self-sustainability
   - 3.2 Perfect population establishment and augmentation techniques
   - 3.3 Assess efficacy of habitat management strategies
   - 3.4 Determine edaphic and hydrologic requirements

4. Develop and implement an outreach program.

C. Narrative Outline of Recovery Actions

1. Conserve natural and introduced Applegate's milk-vetch populations.

The heart of recovery efforts for Applegate's milk-vetch will be to: 1) increase the species' representation from the current three areas to at least six areas with a minimum of two populations occurring at each of the recovery areas; and 2) develop management strategies that provide for long-term stability. Toward these ends, the following actions are needed:

1.1 Inventory for undiscovered populations

Applegate's milk-vetch was long presumed extirpated until its recent rediscovery during field inventories for the species. Although extensive surveys for Applegate's milk-vetch have been carried out by the Oregon Natural Heritage Program and personnel from the Oregon Department of Agriculture, systematic and exhaustive searches are still needed of all potential habitat within the species' presumed historic range, including private lands. Such inventories may reveal additional Applegate's milk-vetch populations which would be invaluable to recovery. Undiscovered populations, if they exist, may harbor unique genotypes for use in establishing new populations, and for population augmentation projects. They would also provide additional opportunities for seed harvesting and preservation of natural populations. For these reasons, extensive searches for Applegate's milk-vetch should be conducted within the Keno area. These opportunities now exist for the recently discovered Wordon population (N. Testa, pers. comm., 1997).

The following inventory procedures are recommended:

1.11 Review aerial photos

Aerial photos of the Lower Klamath Basin should be reviewed as a means of identifying potential habitat for the species. Although aerial photo resolution may not reveal specific habitat attributes useful in

predicting Applegate's milk-vetch presence, photos do provide quick and unrestricted (i.e., no trespass limitations) information on land use. For the purposes of photo interpretation, potential Applegate's milk-vetch habitat will include any undeveloped areas of valley bottom land. Although large, contiguous areas of land may hold the greatest promise of supporting undiscovered Applegate's milk-vetch populations, small and fragmented patches of land should not be discounted as potential sites, as they may harbor remnants of once larger Applegate's milk-vetch occurrences. Use of aerial photos may be coordinated with soil maps, which may also provide useful information about the distribution of alkaline soils and potential habitat.

1.12 Prioritize search areas

As potential Applegate's milk-vetch habitat is identified, search areas should be prioritized, with emphasis assigned to lands within urban and residential growth boundaries, and any other potential habitat believed threatened by imminent disturbance. This strategy may preempt possible population loss during the inventory period.

1.13 Acquire landowner permission for ground searches

Because the vast majority of property in the Lower Klamath Basin is privately owned, obtaining landowner permission will be necessary before searches can be made on private lands. Many lands may belong to absentee landowners, necessitating research of city and county records to determine ownership. Public land management agencies should also be notified, or their permission obtained, prior to inventories conducted on their lands, and should be informed of inventory results.

1.14 Conduct inventories

Inventories for Applegate's milk-vetch should take place in June and July, when the species is in full flower and most conspicuous. Non-flowering plants are extremely difficult to detect, especially in areas

overgrown by grass and weeds. Inventories should be conducted by personnel qualified in the identification of Applegate's milk-vetch and its distinction from closely related species.

1.2 Survey for sites to establish populations

Surveys for potential Applegate's milk-vetch population establishment sites should be coordinated with surveys for undiscovered populations. "Establishment" refers to either the creation of new populations, or the re-introduction of the species to a site known to have once supported a population. Records, such as annotated maps, labeled photocopies of aerial photos, and detailed site descriptions, should be kept of all visited sites containing likely suitable habitat and adequate acreage for population establishment.

1.3 Select population preservation and establishment sites

Once all potential habitat has been inventoried for Applegate's milk-vetch, and after possible population establishment sites have been identified, selection of sites for population preservation and establishment should take place. Because listing decisions are made by the U.S. Fish and Wildlife Service, the Service is responsible to decide which establishment sites will satisfy recovery objectives.

As mentioned in the objectives, at least six Applegate's milk-vetch recovery areas will be required before downlisting to threatened status will be considered. Emphasis should be given to preserving extant populations, as they are vital as seed sources for the establishment of new populations. Natural populations are also inherently more stable than artificially created populations.

Selection of population establishment areas (from the previously developed pool of potential sites) should be based upon factors including, but not necessarily limited to:

Habitat quality: Assess the site's soils for similarity to sites with extant Applegate's milkvetch populations, and for its ability to support native plant species of those sites. Determine the degree of site preparation and rehabilitation required to establish and maintain populations.

Habitat availability: Determine whether the site has adequate acreage of contiguous habitat to provide for population expansion, natural recruitment, possible demographic augmentation, and provision of a surrounding buffer to protect populations from outside land uses.

Landowner interest: Determine the site's availability for purchase, and whether the owners are willing to develop permanent Conservation Agreements (discussed below) or equivalent conservation arrangements.

Surrounding land uses: Determine if surrounding land uses are compatible with population establishment, preservation, and habitat management (such as prescribed burning). Determine if agricultural or other activities would interfere with establishing new populations through curtailment or modification of local herbicide application practices. Determine if public access and site vandalism could be a problem.

Geographic diversity: Applegate's milk-vetch population establishment sites should be spread out to the greatest practical extent (without compromising habitat quality), thereby maximizing geographic diversity and minimizing threats to populations resulting from random mortality events.

One point to consider in the selection of population establishment sites, and recognition of populations for recovery and downlisting purposes, is habitat availability. Limited availability of suitable Applegate's milk-vetch habitat may dictate condensed placement of established populations. Therefore,

although utmost efforts should be made to widely disperse population establishment sites throughout the species' range, it may be necessary to recognize closely-spaced populations as individual entities (when they might otherwise be considered sub-populations or merely separate patches of plants in the same population). A hypothetical example of this situation would be the creation of a second Applegate's milk-vetch population at Miller Island, which contains ample habitat in a rather limited area.

1.4 Secure extant populations and establishment sites

1.41 Acquire habitat

Selected Applegate's milk-vetch population preservation and establishment sites must be permanently secured through purchase, development of legally binding Conservation Agreements between landowners and the U.S. Fish and Wildlife Service, or similar arrangements with other public or private conservation organizations.

1.42 Delineate boundaries

Site boundaries should be visibly marked (preferably fenced) to provide precise and identifiable limits for the purposes of population monitoring and habitat management, and help to prevent unintentional population disturbance resulting from management activities on adjacent lands.

1.5 Establish introduced populations

The following population establishment procedures have been developed based upon propagation and transplantation research conducted by the Oregon Department of Agriculture. These methods should be considered strictly preliminary, as they do not include forthcoming results from ongoing research involving additional transplantation techniques and on-site propagation trials. Final results from these studies will be required before conclusions and recommendations can be made regarding optimal population establishment methods.

1.51 Collect seeds

Population establishment, by any method, will require a significant seed reserve. An effective method of mass seed collection involves the placement of breathable nylon mesh bags over inflorescences before fruit dehiscence. These bags allow efficient collection of all seeds produced, and do not harm plants. Bags may be affixed before flowers are produced, as plants produce seeds in the absence of insect pollinators. This strategy can also protect inflorescenses from herbivory by caterpillars when efforts are made to remove all larvae before bag placement (ODA, unpublished). Data to date indicate no advantage to outcrossed versus inbred progeny; however, more study of the relative performance of plants based on parentage may be useful.

1.52 Propagation

Applegate's milk-vetch seeds germinate readily after scarification of the seed coat and placement in moist soil. The authors have experienced some difficulty in growing plants in the greenhouse due to root rot (*Fusarium oxysporum*) and some damping-off infection. However, inoculation of potting medium with native soil containing mycorrhizal fungi has proven not only to stimulate plant growth, but also improve plant resistance to root rot. Experiments are currently underway to further explore the use of naturally occurring and commercially available mycorrhizal and bacterial inoculants in the propagation of the species (ODA, unpublished). Following seed germination, Applegate's milk-vetch develops rapidly, and can reach mature, reproductive size in six months when amply fertilized, watered, and supplied with enhanced (at least 12-hour) photoperiods.

1.53 Prepare sites

Depending upon the extent of vegetative groundcover, establishment sites may require burning, scarification, manual weed and shrub removal, or treatment with contact (soil-inactive) herbicide, to provide a

non-competitive environment conducive to establishing transplants or seedlings.

1.54 Population establishment (outplanting)

Preliminary field transplant trials conducted by the Oregon Department of Agriculture have resulted in limited transplant success. Additional transplantation methods involving plants of different ages and planting schedules (fall versus spring) are currently being investigated, as is on-site propagation utilizing different seed burial treatments. Results from these studies may provide better population establishment techniques.

1.6 Habitat management

Simple protection of plants from human disturbance will likely be inadequate to indefinitely maintain Applegate's milk-vetch in its altered and dynamic environment. In addition to protection, human intervention in the form of active, comprehensive habitat management will be needed to encourage natural population recruitment and achieve the population size and age structure criteria discussed in this plan.

1.61 Determine management needs

Habitat management needs will likely differ subtly between populations, depending upon habitat conditions, especially weed proliferation, at each site. To help ensure the development of efficient and effective habitat management plans, it will be necessary to precisely identify which management actions are most urgently needed for each population. These may include, but are not limited to: prescribed burning, selective herbicide application, ground scarification, mowing, manual shrub and weed control, fencing, hydrologic modifications, and pesticide application to control insect herbivory and seed predation.

1.62 Develop written management plans

Once management needs have been identified for each population, they should be incorporated into written population management plans. Management plans should detail the nature, methods, intensity, frequency and timing of management actions to be implemented. Specific attention should be given to tailoring management strategies to minimize potentially adverse impacts to populations, such as scheduling activities during the species' dormant period in late summer and early fall (TNC did not notice a complete dormant period in 1996), and washing vehicle tires and equipment (if any) to minimize introduction of weeds.

1.63 Implement management actions

Management actions should be carried out according to the written population management plans.

1.7 Evaluate population status

The following general methods are recommended for evaluating population status and determining if, or when, populations have achieved the size and structure criteria discussed in this recovery plan:

1.71 Population census

Applegate's milk-vetch populations should undergo complete annual censusing to determine number of individuals, identify trends and fluctuations in population size and geographic movement, assess possible population augmentation needs, and identify when populations achieve (or fall below) the recovery plan size criterion of 1,500 individuals. Habitat management actions should be evaluated to assess population response to management, and determine which strategies are most effective in benefitting the species. An example of this scenario would be to pair unmanaged plots with plots subjected to various management treatments, followed by multi-year tracking and

comparisons of plant vigor and levels of population recruitment. This approach may also be used to compare population response to different intensities and frequencies of management treatments. Censusing should be conducted consistently from year to year, and include mapping of population boundaries.

1.72 Demographic monitoring

Randomly chosen subsets of populations should be monitored annually to provide needed information on population age structure and dynamics, in order to project long-term population trends using an established modeling program. This monitoring should be incorporated into demographic research on the efficacy of different management strategies (see Recovery Action 3.3). As with population censusing, monitoring methods must be consistent from year to year. Stage-based monitoring will involve annual tracking of the fates of individuals within sampling plots, including data collection on seedling recruitment, plant age/size, and plant mortality and dormancy. Investigations of seed bank size and dynamics are also recommended, and could be incorporated into the demographic model.

1.73 Assess population augmentation needs

Analysis of the census and demographic data discussed above will not only indicate if and when populations have attained size and structure recovery goals, but will also identify the need for population augmentation through introduction of outside individuals or propagules. Populations may require augmentation, in addition to habitat management, if they remain smaller than the recovery plan size criterion and/or decline or fail to expand.

1.8 Augment populations (if necessary)

Population augmentation will use the procedures previously discussed for population establishment (Recovery Action 1.5). To maintain any genetic

variation between populations, augmentation at any one site should only utilize plants and propagules from a single parent population. Outside genotypes from other recovery areas should only be considered as a last resort where the parent population is small, resulting in a threat of inbreeding depression which could cause eminent extirpation.

2. Long-term, off-site seed storage

Banking (long-term cryogenic storage) of Applegate's milk-vetch seeds will provide an additional level of security to the recovery and survival of the species, by creating a demographic and genetic reserve of plant propagules. Off-site seed storage may be particularly vital in instances when natural soil seed banks are depleted due to poor seed production and pre- and post-dispersal seed mortality, or destroyed by natural or anthropogenic catastrophe. Stored seeds may be useful in establishing and augmenting Applegate's milk-vetch populations, mitigation of future population losses, and potential sources of genetic variability in the event populations suffer from inbreeding depression and/or allele fixation through drift.

2.1 Collect seeds

Seed collection will use the methods discussed in task 1.5, using breathable nylon mesh bags to capture seeds as the pods open. Seeds will be collected from many individuals in each population to capture intra-population genotypic variability.

2.2 Store and test seeds

Seeds should be deposited at a recognized seed banking facility such as the Berry Botanic Garden Seed Bank for Rare and Endangered Plants of the Pacific Northwest, in Portland, Oregon. Seed storage in additional facilities will enhance the security of seed collections in the event one facility experiences failure. Once stored, seeds should be regularly tested for viability, as a means of assessing seed collection re-stocking needs.

3. Conduct further research

The following areas of research must be addressed to increase our knowledge about the nature and extent of Applegate's milk-vetch threats, and improve the species' prospects of recovery.

3.1 Define population self-sustainability

Additional research is needed to define what constitutes self-sustainable populations, both in terms of population size and population age structure. Such information is vital in determining the long-term viability of extant Applegate's milk-vetch populations, assessing the biological validity of population size recovery criteria discussed in this plan, and identifying if and when populations have achieved the self-sustainability criteria discussed herein.

3.2 Perfect population establishment and augmentation techniques

Although effective seed collection and off-site plant propagation techniques have been developed for Applegate's milk-vetch, limited transplantation efforts have so far yielded little success. Work is underway to investigate the efficacy of experimental, on-site seeding and additional transplant techniques. Because population augmentation and establishment are central to recovery efforts for Applegate's milk-vetch, the techniques must become effective and reliable. The role of soil organisms in the ecology of Applegate's milk-vetch is of vital interest as well, and requires particular research attention.

3.3 Assess efficacy of habitat management strategies

Site management will play a crucial role in the maintenance of extant and established Applegate's milk-vetch populations. Habitat manipulations must be accompanied by demographic monitoring designed to assess population responses to various types, intensities, and frequencies of management. This work will help identify which strategies are most useful in benefitting the species. Management strategies to be examined may include, but are not limited to: prescribed burning, mowing, application of herbicides, manual

shrub and weed removal, application of systemic insecticides to reduce herbivory and seed predation, and hydrologic rehabilitation.

3.4 Edaphic and hydrologic requirements

Further research is needed to identify the extent of edaphic and hydrologic conditions tolerated by Applegate's milk-vetch. Determine to what degree of tolerance the species has to alkalinity and moisture, and if and to what extent these factors dictate where the species can grow, where populations can be established, and what associate species will co-occur with Applegate's milk-vetch. Determine if hydrologic restoration (i.e. the undoing of previous modifications such as ditches and dikes) is needed to maintain optimal habitat for the species. This information will help better define search areas to find or establish new populations for the species.

4. Develop and implement an outreach program.

While this recovery plan emphasizes cooperation with individual landowners, increasing public awareness of Applegate's milkvetch will facilitate efforts to preserve this plant and restore its habitat. Prepare informational brochures, audio-visual, and sign programs on habitat restoration and recovery. Disseminate the brochures to affected landowners and other community facilities. Provide the audio-visual materials to public facilities such as National Wildlife Refuge interpretive programs and school programs.

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PART III IMPLEMENTATION SCHEDULE

The following Implementation Schedule is a guide for meeting the objectives discussed in Part II of this plan. This schedule indicates task priorities, task numbers, brief task descriptions, duration of tasks, the responsible agencies, and lastly, estimated costs. These actions, when accomplished, should bring about the recovery of the species and protect its habitat. Priorities in column one of the following implementation schedule are assigned as follows:

Priority 1: An action that must be taken to prevent extinction or to prevent the species from declining irreversibly in the foreseeable future.

Priority 2: An action that must be taken to prevent a significant decline in the species' population/habitat quality or some other significant negative impact short of extinction.

Priority 3: All other actions necessary to meet the recovery objective.

Key to Acronyms and other words or phrases used in Implementation Schedule

BBG — Berry Botanic Garden
Continual — Tasks which, once begun, will continue for the duration of the recovery period.
FWS — US Fish and Wildlife Service, Klamath Falls Office
ODA — Oregon Department of Agriculture
ODFW — Oregon Department of Fish and Wildlife
On-going — Tasks currently being implemented and expected to occur for the duration of the recovery period.
Task Total Cost Projected cost of task from start to completion.
TBD — To be determined
TNC — The Nature Conservancy

Recovery Plan Implementation Schedule for Applegate's Milk-Vetch

Priority #	Task #	Task Description	Task Duration (years)	Agencies	Cost Estimates, in thousands of dollars						Comments
					Task Total	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	
1	1.11	Review aerial photos	1	FWS	0.5	0.5					
				ODA	0.5	0.5					
				TNC	1.0	1.0					
1	1.12	Prioritize search areas	1	FWS	0.5	0.5					
				ODA	0.5	0.5					
				TNC	1.0	1.0					
1	1.13	Acquire landowner permission	2	FWS	14.0	7.0	7.0				
				ODA	14.0	7.0	7.0				
				TNC	14.0	7.0	7.0				
1	1.14	Conduct inventories	4	FWS	14.0		3.5	3.5	3.5	3.5	
				ODA	14.0		3.5	3.5	3.5	3.5	
				TNC	14.0		3.5	3.5	3.5	3.5	
1	1.2	Inventory for introduced population establishment sites	4	FWS	14.0		3.5	3.5	3.5	3.5	
				ODA	14.0		3.5	3.5	3.5	3.5	
				TNC	14.0		3.5	3.5	3.5	3.5	

Priority #	Task #	Task Description	Task Duration (years)	Agencies	Cost Estimates, in thousands of dollars						Comments
					Task Total	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	
1	1.3	Select population preservation and establishment sites	1	FWS ODA TNC ODFW	1.5 1.5 1.5 1.5						To be implemented in FY2003
1	1.41	Acquire habitat	TBD	FWS TNC	TBD TBD						
1	1.42	Delineate boundaries	1	FWS ODA TNC	0.5 0.5 7.5						To be implemented in FY2005
1	1.51	Collect seeds	Continual	FWS ODA TNC	3.5 21.0 21.0						To begin implementation in FY2004
1	1.52	Propagation	Continual	FWS ODA TNC	3.0 72.0 72.0						To begin implementation in FY2005
1	1.53	Prepare sites	Continual	FWS ODA TNC	3.0 72.0 72.0						To begin implementation in FY2005

Priority #	Task #	Task Description	Task Duration (years)	Agencies	Cost Estimates, in thousands of dollars						Comments
					Task Total	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	
1	1.54	Population establishment (outplanting)	Continual	FWS ODA TNC	3.0 72.0 72.0						To begin implementation in FY2005
1	1.61	Determine management needs	3	FWS ODA TNC ODFW	6.0 6.0 6.0 6.0						To begin implementation in FY2003
1	1.62	Develop written management plans	2	FWS ODA TNC ODFW	12.0 2.0 2.0 2.0						To begin implementation in FY2006
1	1.63	Implement management actions	on-going	FWS ODA TNC ODFW	TBD TBD TBD TBD						Management actions currently underway by TNC at Ewauna Flat and ODA at Miller Island.
1	1.71	Population census	on-going	FWS ODA TNC ODFW	45.5 6.5 19.5 19.5	0.5 0.5 1.5 1.5	0.5 0.5 1.5 1.5	0.5 0.5 1.5 1.5	0.5 0.5 1.5 1.5	0.5 0.5 1.5 1.5	Task cost for FWS expected to increase to $7K for 6 years beginning in FY2005 based on contract administration

Priority #	Task #	Task Description	Task Duration (years)	Agencies	Cost Estimates, in thousands of dollars						Comments
					Task Total	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	
1	1.72	Demographic monitoring	10	FWS	66.0	6.0	6.0	6.0	6.0	6.0	
				ODA	66.0	6.0	6.0	6.0	6.0	6.0	
				TNC	66.0	6.0	6.0	6.0	6.0	6.0	
1	1.73	Assess augmentation needs	on-going	FWS	56.0						To begin implementation in FY2003
				ODA	4.0						
				TNC	4.0						
				ODFW	4.0						
1	1.8	Augment populations (if necessary)	Continual	FWS	TBD						
				ODA	TBD						
				TNC	TBD						
				ODFW	TBD						
2	2.1	Collect seeds	on-going	FWS	see						Cost figures in task 1.51
				ODA	task						
				TNC	1.51						
2	2.2	Store and test seeds	on-going	FWS	6.5	0.5	0.5	0.5	0.5	0.5	BBG costs expected to increase to 3.0 in FY2003 and to 6.0 in FY2008 due to increasing seed inventory.
				ODA	6.5	0.5	0.5	0.5	0.5	0.5	
				BBG	40.5	1.5	1.5	1.5	1.5	1.5	

Priority #	Task #	Task Description	Task Duration (years)	Agencies	Cost Estimates, in thousands of dollars						Comments
					Task Total	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	
3	3.1	Define population self-sustainability	1	FWS ODA TNC BBG	1.0 1.0 1.0 1.0						To be implemented in FY2009
3	3.2	Perfect population establishment and augmentation techniques	5	FWS ODA	50.0 50.0	10.0 10.0	10.0 10.0	10.0 10.0	10.0 10.0	10.0 10.0	
3	3.3	Assess efficacy of habitat management strategies	on-going	FWS ODA TNC	13.0 13.0 78.0	1.0 1.0 6.0	1.0 1.0 6.0	1.0 1.0 6.0	1.0 1.0	1.0 1.0	
3	3.4	Evaluate edaphic and hydrologic requirements	3	FWS ODA	30.0 30.0	10.0 10.0	10.0 10.0	10.0 10.0			
3	4	Develop and implement an outreach program.	7	FWS	8.0	1.0	2.0	1.0	1.0	1.0	

APPENDIX 1: Summary of Public Comment on the Draft Recovery Plan for Applegate's Milk-Vetch (*Astragalus applegatei*).

On September 25, 1997, the Service released the Draft Recovery Plan for Applegate's Milk-Vetch (*Astragalus applegatei*) for a 60-say comment period that ended November 24, 1997, for Federal agencies, State and local governments, and members of the public (62 **Federal Register** 50396).

Two letters were received, one from an expert on the genus *Astragalus* who, overall, was "very impressed by the quality and comprehensiveness of the recovery plan" and the other from a member of the public. Several issues raised by the member of the public are matters of opinion, which are not relevant to the recovery of the milk-vetch.

Summary of Comments and Service Responses

Comment: The recovery plan is based on non-existent scientific data.

Response: The listing process identified threats to Applegate's milk-vetch that warranted its listing as an endangered species. It would be desirable, as explained in the recovery plan, to know more about the plant's life history and ecology. But adequate information is available to reduce those threats.

Comment: The goal (at least as stated in the Federal Register summary of the plan) of maintaining the genetic variability of the three populations is not directly addressed. In addition to addressing the above goal, a survey of genetic variation could test the hypothesis that no genetic differentiation occurs among the three known populations. If significant genetic differentiation does exist, then the strategy for establishing new populations will need to be modified.

The close geographic proximity of the three populations might suggest genetic differentiation is unlikely. However, gene flow among Astragalus populations can be quite limited (Liston 1992, Systematic Botany 17: 367-379). Furthermore, significant genetic differentiation within *Astragalus cremnophylax* var. *cremnophylax* has recently been documented (Travis, Maschinski, and Keim 1996, Molecular Ecology 5: 735-745). This species, the sentry milk-vetch, is restricted to Grand Canyon National Park. DNA fingerprinting of 96 individuals revealed large genetic distances among three populations separated by 14-17 kilometers. Even more striking, subpopulations separated by only 1-2 kilometers also exhibited some genetic differences. These results allowed the authors to propose specific recommendations for breeding programs to increase diversity and preserve unique genetic information in reintroduced populations.

Response: Such genetic information, although interesting, would be somewhat peripheral to the immediate recovery of the species. Funds would better be allocated to the other, more urgent, recovery tasks identified in the recovery plan. It is possible that a future revision of this plan will place a higher priority on obtaining genetic data.

While the proposed molecular work could be useful, there are attributes peculiar to the case of *A. applegatei* that render such work unnecessary. First, as all three known extant localities of the species are near one another, with no identifiable barriers to genetic exchange outside of recent anthropogenic habitat fragmentation, is unlikely that genetic differentiation has had an opportunity to develop between what was likely a single continuous population prior to European settlement. Further, even if the extant occurrences *do* exhibit genetic variability, the recovery plan already takes steps to maintain, and capitalize upon, these differences. For instance, the plan calls for collecting seeds from as many individuals within populations as possible, to maximize capture of any within-population genetic diversity. The plan stipulates that any population augmentation projects utilize only seeds/transplants originating from each respective occurrence (to maintain potential genetic uniqueness), unless low genetic diversity is suspected of contributing to population decline. In the event that low genetic diversity is believed to be a problem, the plan calls for introducing

seeds/transplants from outside population(s), just in case they do harbor unique alleles.

By presuming genetic differentiation among extant sites, the plan precludes the need for expensive molecular analysis. Perhaps in the future, if additional populations are discovered over a wider geographic or ecological range, it will prove useful to conduct genetic surveys. Accordingly, the recovery plan has not been modified to accommodate these comments, but future modifications are not precluded.

APPENDIX 2: Mailing list for draft recovery plan. Reponse is marked with an asterisk (*).

Senator Gordon Smith
121 SW Salmon, Suite 1250
Portland, OR 97204

Senator Ron Wyden
310 W 6th, #118
Medford, OR 97501

Representative Elizabeth Furse
1st Street & Independence Ave, SE
Washington, DC 20515

Representative Peter DeFazio
Independence Ave & S. Capitol St, SW
Washington, DC 20515

Representative Darlene Hooley
Independence & New Jersey Ave, SE
Washington, DC 20515

Governor John Kitzhaber
254 State Capitol
Salem, OR 97310

Klamath County Commissioners
409 Pine Street
Klamath Falls, OR 97601

Mayor Todd Kellstrom
500 Klamath Avenue
Klamath Falls, OR 97601

Allen Robert Willis
Army Corps of Engineers
333 SW 1st Ave
Portland, OR 97208

Joel Shaich
Environmental Protection Agency
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Natural Resources Conservation Service
635 Capitol St, NE
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